



BLUE CARBON: NATURE'S OCEANIC GIFT

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Introduction

Blue carbon, the carbon captured and stored by coastal and marine ecosystems, is increasingly recognized as a powerful tool in the global fight against climate change. These ecosystems—mangroves, tidal marshes, and seagrasses—have an extraordinary ability to capture and store carbon at rates significantly higher than terrestrial forests, often referred to as "blue carbon sinks." Protecting and restoring these ecosystems can provide an effective solution to mitigate greenhouse gas emissions while safeguarding biodiversity and enhancing the resilience of coastal communities.

Role of Blue Carbon Ecosystems in Climate Mitigation

Carbon Sequestration Capacity: Blue carbon ecosystems are among the most efficient at capturing and storing carbon. For instance, mangroves sequester carbon up to four times faster than tropical rainforests. The carbon is stored both in the plants themselves and in the sediments beneath these ecosystems. When undisturbed, these systems can lock away carbon for centuries or even millennia.

Carbon Burial: The carbon stored in blue carbon ecosystems is particularly valuable because it is "buried" in the sediment, making it less susceptible to release back into the atmosphere. This is in stark contrast to terrestrial ecosystems, where carbon may be released if vegetation is disturbed or soil erosion occurs.

Long-Term Impact: By conserving and restoring blue carbon ecosystems, we are ensuring that carbon remains out of the atmosphere for

extended periods. This helps to stabilize atmospheric CO₂ levels and counterbalance emissions from human activities.



Fig.1 Blue Carbon Ecosystems

Different Blue Carbon Ecosystems

Mangroves:

Characteristics: Mangroves are coastal forests found in tropical and subtropical areas. Their root systems trap sediments, which helps prevent coastal erosion and promotes the accumulation of organic matter.

Carbon Sequestration: Mangroves can store up to 3-5 times more carbon per hectare than tropical forests. They sequester carbon both in the above-ground biomass and in the sediment below the roots, which can remain locked for long periods if the ecosystem remains intact.

Threats: Mangrove forests are highly threatened by deforestation due to agricultural expansion, aquaculture, and urban development. Loss of mangroves releases the stored carbon back into the atmosphere, contributing to climate change.

Tidal Marshes:

Characteristics: Tidal marshes are coastal wetlands found in temperate zones. They are rich in organic matter, and their complex plant communities, such as salt marsh grasses, trap carbon from the atmosphere.

Carbon Sequestration: These ecosystems are excellent carbon sinks, storing large amounts of carbon both in plant biomass and in the soil. The burial of carbon in marsh sediments can be enhanced by sediment deposition during tidal flows.

Threats: Tidal marshes are vulnerable to human encroachment and rising sea levels. When they are drained for agriculture or development, the stored carbon is often released, contributing to greenhouse gas emissions.

Seagrasses:

Characteristics: Seagrasses are flowering plants that grow underwater in shallow coastal areas. They form extensive meadows along coastlines, providing habitat for marine life and stabilizing the seabed.

Carbon Sequestration: Seagrasses capture carbon both in their living biomass and in the sediment beneath them. They are particularly effective at trapping fine organic matter and storing carbon in the seabed.

Threats: Seagrass meadows are threatened by pollution, sedimentation, and climate change. Eutrophication, caused by nutrient runoff from agriculture, can lead to algal blooms that smother seagrasses. Furthermore, warming waters and ocean acidification put these vital ecosystems at risk.

The Value of Blue Carbon Beyond Climate Mitigation

Biodiversity Conservation: Blue carbon ecosystems provide essential habitat for a wide variety of marine and terrestrial species. Mangroves, for example, are home to numerous

fish species, crabs, and mollusks, many of which are commercially important. Seagrass meadows and tidal marshes also support a range of marine life, from small invertebrates to larger species like sea turtles and dugongs.

Coastal Protection: Blue carbon ecosystems serve as natural barriers, protecting coastal areas from storm surges, erosion, and flooding. Mangroves, with their dense root systems, help absorb the impact of storms, while seagrasses and tidal marshes stabilize sediments and reduce coastal erosion.

Livelihoods and Sustainable Fisheries: Coastal communities depend on these ecosystems for their livelihoods. Healthy blue carbon systems support fisheries by providing breeding and nursery grounds for fish, shellfish, and other marine organisms. Moreover, these ecosystems offer sustainable resources for local communities, including wood, honey, and medicinal plants.

Threats to Blue Carbon Ecosystems and Solutions

Degradation and Loss: Coastal ecosystems are among the most rapidly disappearing ecosystems on Earth. Mangrove forests have been reduced by approximately 50% globally in the past century, and seagrass meadows are also declining at an alarming rate. **Solutions:** Replant mangroves and rehabilitate degraded seagrass meadows. Establish marine protected areas (MPAs) to safeguard critical habitats from exploitation.

Climate Change: Rising sea levels, increasing storm frequency and intensity, and ocean acidification pose significant threats to blue carbon ecosystems. These ecosystems are highly sensitive to temperature changes, salinity levels, and water quality. **Solutions:** Reduce GHG emissions globally to slow climate change and its impacts on these ecosystems. Use mangroves and seagrass meadows as natural buffers against storm surges and rising sea levels.

Human Activities: Coastal development, industrial activities, aquaculture, and agricultural runoff significantly threaten blue carbon ecosystems. Conversion of mangroves and tidal marshes into shrimp farms or urban areas leads to the release of stored carbon and the destruction of critical habitats. **Solutions:** Adopt sustainable land-use practices that prioritize conservation and reduce harmful impacts from agriculture and aquaculture. Implement stricter regulations to minimize agricultural runoff, industrial waste, and urban pollution. Introduce carbon credits or payments for ecosystem services to encourage conservation over exploitation. Enforce coastal zoning laws that protect critical blue carbon habitats from development.

Conclusion

Blue carbon ecosystems play a crucial role in combating climate change, safeguarding biodiversity, and shielding coastal communities. Protecting, restoring, and sustainably managing these ecosystems can significantly boost their capacity to capture and store carbon, offering a powerful natural solution to global warming. To realize their full potential as climate champions, urgent measures must be taken to prevent further degradation.

References

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